UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/645,645	08/22/2003	Chandra Mouli	M4065.0674/P674	8786

45374 7590 10/01/2010

DICKSTEIN SHAPIRO LLP
1825 EYE STREET, NW
WASHINGTON, DC 20006

EXAMINER	
MATTHEWS, COLLEEN ANN	

ART UNIT	PAPER NUMBER
2811	

MAIL DATE	DELIVERY MODE
10/01/2010	PAPER

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Office Action Summary	Application No.	Applicant(s)	
	10/645,645	MOULI, CHANDRA	
	Examiner	**Art Unit**	
	Colleen A. Matthews	2811	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on 20 November 2009.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1-3,5-13,15-37 and 55* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1-3,5-13,15-37 and 55* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☐ Notice of References Cited (PTO-892)

2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)

3) ☒ Information Disclosure Statement(s) (PTO/SB/08)
Paper No(s)/Mail Date *10/21/2003,09/07/2007*.

4) ☐ Interview Summary (PTO-413)
Paper No(s)/Mail Date. _____ .

5) ☐ Notice of Informal Patent Application

6) ☐ Other: _____.

DETAILED ACTION

Continued Examination Under 37 CFR 1.114

A request for continued examination under 37 CFR 1.114, including the fee set forth in 37 CFR 1.17(e), was filed in this application after final rejection. Since this application is eligible for continued examination under 37 CFR 1.114, and the fee set forth in 37 CFR 1.17(e) has been timely paid, the finality of the previous Office action has been withdrawn pursuant to 37 CFR 1.114. Applicant's submission filed on 11/20/2009 has been entered.

Claim Rejections - 35 USC § 102

The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

> A person shall be entitled to a patent unless –
>
> (e) the invention was described in (1) an application for patent, published under section 122(b), by another filed in the United States before the invention by the applicant for patent or (2) a patent granted on an application for patent by another filed in the United States before the invention by the applicant for patent, except that an international application filed under the treaty defined in section 351(a) shall have the effects for purposes of this subsection of an application filed in the United States only if the international application designated the United States and was published under Article 21(2) of such treaty in the English language.

Claims 1-3, 5-6, 9 and 11-12 are rejected under 35 U.S.C. 102(e) as being anticipated by U.S. Pub. No. 2002/0171077 to Chu et al. (Chu).

Re Claim 1: Chu discloses a pixel cell for an image sensor, the pixel cell comprising:

a photodiode (Fig 4A, area corresponding to electrodes 11) for generating charge in response to light and for amplifying the generated charge, the photodiode being

formed within a substrate (1) and below an upper surface thereof and comprising at least two of a first layer (35) having a first band gap (band gap corresponding to material of $Si_{1-x}Ge_x$) and at least two of a second layer (36) having a second band gap (band gap corresponding to material of $Si_{1-z}Ge_z$),

wherein the first layers are alternated with the second layers, wherein the first layers are not in direct contact with one another and the second layers are not in direct contact with one another, and

wherein the at least two first layers and the at least two second layers are configured to promote ionization by a first carrier type and suppress ionization by a second carrier type in the presence of an electric field (band gap energies are shown in Fig 4B and would create ionization and suppression of carriers)

a gate (12) of a transistor (15) adjacent to the photodiode, the transistor for transferring the amplified charge from the photodiode; and

a graded buffer layer (2) beneath a bottom layer of the photodiode.

Re claim 2-3: Chu discloses the pixel cell as above wherein a difference between the conduction band energies of the first and at least second layer is greater than a difference between the valence band energies of the first and at least second layer and such that a difference between the valence band energies of the first and at least second layer is greater than a difference between the conduction band energies of the first and at least second layer (see Fig 4B).

Re claims 5-6: Chu discloses the pixel cell as above wherein the at least two first layers and the at least two second layers are formed of a material selected from the

group consisting of Si, Si_xGe_{1-x}, $Si_xGe_{1-x}C_y$, GaAs, GaAlAs, InP, InGaAs, or InGaAsP and wherein the first layer is Si and the second layer is SiGe (Si_xGe_{1-x} and $Si_{1-z}Ge_z$ ¶0039).

Re claim 9: Chu discloses the pixel cell as above wherein the first layer is Si_xGe_{1-x} and the second layer Si_yGe_{1-y} (Si_xGe_{1-x} and $Si_{1-z}Ge_z$ ¶0039).

Regarding claim 11, Chu discloses the pixel cell of claim 1 where at least a portion of the photodiode is at a level below a level of a top surface of the substrate (see Fig 4A).

Re claim 12, Chu discloses the pixel cell as above, wherein the photodiode comprises approximately 10 to approximately 100 layers (8 shown in Fig 4A and 8 is considered as approximately 10).

Claim Rejections - 35 USC § 103

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

Claims 7-8, 10, 13 and 55 are rejected under 35 U.S.C. 103(a) as being unpatentable over U.S. Pub. No. 2002/0171077 to Chu et al. (Chu) in view of U.S. Pat. No. 5,818,322 to Tasumi.

Regarding claims 7-8, Chu discloses the pixel cell as above including wherein the photodiode comprises at least four layers of Si and at least four layers of SiGe (shown in Fig 4A). Chu fails to disclose wherein the layers of Si are doped to a first conductivity type and wherein the layers of SiGe are doped to a second conductivity type.

Tasumi discloses where the layers of Si are doped to a first conductivity type and the layers of SiGe as taught by Tasumi are doped to a second conductivity type (col 5 lines 66-67 and col 6 lines 1-32). It would have been obvious to one of ordinary skill in the art at the time the invention was made to have the layers of Si are doped to a first conductivity type and the layers of SiGe as taught by Tasumi in order to improve device characteristics, such as enhancing absorption and speed of the image sensor and reducing dark current.

Regarding claims 10, Chu discloses the pixel cell as above.Chu fails to disclose where the first layer is $Si_xGe_{1-x}C_y$ and the second layer is $Si_xGe_yC_z$. Tasumi discloses the pixel cell where the first layer is $Si_xGe_{1-x}C_y$ and the second layer is $Si_xGe_yC_z$ (col 3 line 63). It would have been obvious to one of ordinary skill in the art at the time the invention was made to have the first layer as $Si_xGe_{1-x}C_y$ and the second layer as $Si_xGe_yC_z$ as in Tasumi in order to improve device characteristics, such as enhancing absorption and speed of the image sensor and reducing dark current.

Regarding claim 13, Chu discloses the pixel cell as above. Chu fails to disclose wherein each of the layers have a thickness of approximately 50 – 300 angstroms. Tasumi discloses wherein each of the layers have a thickness of approximately 50- 300

angstroms (50 angstroms, col 6 line 24). It would have been obvious to one of ordinary skill in the art at the time the invention was made to use the thickness of the layers between 50 – 300 angstroms as in Tasumi in order to maximize the performance of the device such as reducing dark current.

Re Claim 55: Chu discloses a pixel cell for an image sensor, the pixel cell comprising:

a photodiode (Fig 4A, area corresponding to electrodes 11) for generating charge in response to light and for amplifying the generated charge, the photodiode being formed within a substrate (1) and below an upper surface thereof and comprising at least two of a first layer (35) having a first band gap (band gap corresponding to material of $Si_{1-x}Ge_x$) and at least two of a second layer (36) having a second band gap (band gap corresponding to material of $Si_{1-z}Ge_z$),

wherein the first layers are alternated with the second layers, wherein the first layers are not in direct contact with one another and the second layers are not in direct contact with one another, and

wherein the at least two first layers and the at least two second layers are configured to promote ionization by a first carrier type and suppress ionization by a second carrier type in the presence of an electric field (band gap energies are shown in Fig 4B and would create ionization and suppression of carriers)

a gate (12) of a transistor (15) adjacent to the photodiode, the transistor for transferring the amplified charge from the photodiode.

Chu fails to disclose the photodiode being formed within a trench in the substrate. Tasumi teaches a photodiode in a trench (4) within a substrate (1). It would have been obvious to one of ordinary skill in the art at the time the invention was made to modify Chu to include the trench as taught by Tasumi in order to improve efficiency of the photodiode (see Tasumi abstract).

Claim 15-22, 25, 27-32, 35-37 and 55 are rejected under 35 U.S.C. 103(a) as being unpatentable over U.S. Pub. No. 2002/0171077 to Chu et al. (Chu) in further view of U.S. Pat. No. 6,232,626 to Rhodes.

Regarding claims 15, 16 and 17, discloses the pixel cell of claim 1. Chu fails to disclose where there is a reset transistor for resetting the photodiode to a predetermined voltage, a floating diffusion region, where the transistor is a transfer transistor for transferring charge from the photodiode to the floating diffusion region and where the photodiode is part of a CMOS image sensor. Rhodes teaches a photodiode (Fig 5, 24, for example) where there is a reset transistor (31) for resetting the photodiode to a predetermined voltage, a floating diffusion region (30), where the transistor is a transfer transistor (28) for transferring charge from the photodiode to the floating diffusion region and where the photodiode is part of a CMOS image sensor (see Abstract). It would have been obvious to one of ordinary skill in the art at the time the invention was made to modify Chu to include the features of Rhodes to provide a fully operational low cost device.

Regarding claim 18, Chu discloses the pixel cell of claim 1. Chu fails to disclose where the photodiode is part of a charge coupled device image sensor. Rhodes teaches using photodiodes as part of a charge coupled device image sensor (see Col 1). It would have been obvious to one of ordinary skill in the art at the time the invention was made to modify Chu to have a silicon-on-insulator substrate like Rhodes to provide for image acquisition for small sized imaging applications.

Regarding claim 19, Chu discloses the pixel cell of claim 1. Chu fails to disclose the substrate as silicon-on-insulator. Rhodes discloses a pixel cell where the substrate is a silicon-on-insulator substrate (col 6 lines 46-50). It would have been obvious to one of ordinary skill in the art at the time the invention was made to modify Chu to have a silicon-on-insulator substrate like Rhodes to improve device isolation between devices on the substrate.

Re Claim 20: Chu discloses a pixel cell for an image sensor, the pixel cell comprising:

a photodiode (Fig 4A, area corresponding to electrodes 11) formed within a substrate (1) and below an upper surface thereof,

the photodiode comprising at least two of a first layer (35) comprising a first material ($Si_{1-x}Ge_x$) and at least two of a second layer (36) comprising a second material ($Si_{1-z}Ge_z$),

wherein the first layers are not in direct contact with one another and the second layers are not in direct contact with one another, and

wherein the layers are configured such that a difference between the conduction band energies of the first and second materials and a difference between the valance band energies of the first and second materials promotes ionization by a first carrier type and suppress ionization by a second carrier type in the presence of an electric field (band gap energies are shown in Fig 4B and would create ionization and suppression of carriers) and wherein the first layers are alternated with the second layers;

a gate (12) of a transistor (15) adjacent to the photodiode, the transistor for transferring the amplified charge from the photodiode; and

a graded buffer layer (2) beneath a bottom layer of the photodiode.

Chu fails to disclose an array of pixel cells at a surface of a substrate, wherein at least one of the pixel cells comprises the photodiode. Rhodes teaches an array of pixel cells at a surface of a substrate, wherein at least one of the pixel cells comprises the photodiode. It would have been obvious to one of ordinary skill in the art at the time the invention was made to modify Chu to include the features of Rhodes to provide a fully operational low cost device.

Re claims 21-22: Chu discloses the pixel cell as above wherein the at least two first layers and the at least two second layers are formed of a material selected from the group consisting of Si, Si_xGe_{1-x}, $Si_xGe_{1-x}C_y$, GaAs, GaAlAs, InP, InGaAs, or InGaAsP and wherein the first layer is Si and the second layer is SiGe (Si_xGe_{1-x} and $Si_{1-z}Ge_z$ ¶0039).

Re claim 25: Chu discloses the pixel cell as above wherein the first layer is Si_xGe_{1-x} and the second layer Si_yGe_{1-y} (Si_xGe_{1-x} and $Si_{1-z}Ge_z$ ¶0039).

Re claim 27, Chu discloses the pixel cell as above, wherein the photodiode comprises approximately 10 to approximately 100 layers (8 shown in Fig 4A and 8 is considered as approximately 10).

Regarding claims 28-29, Chu as modified by Rhodes discloses the pixel cell of claim 20. Chu fails to disclose where there is a reset transistor for resetting the photodiode to a predetermined voltage, a floating diffusion region, where the transistor is a transfer transistor for transferring charge from the photodiode to the floating diffusion region . Rhodes further teaches a photodiode (Fig 5, 24, for example) where there is a reset transistor (31) for resetting the photodiode to a predetermined voltage, a floating diffusion region (30), where the transistor is a transfer transistor (28) for transferring charge from the photodiode to the floating diffusion region. It would have been obvious to one of ordinary skill in the art at the time the invention was made to modify Chu to include the features of Rhodes to provide a fully operational low cost device.

Regarding claims 30-31, Chu as modified by Rhodes discloses the pixel cell of claim 20. Chu fails to disclose the pixel cell further comprises readout circuitry connected to a floating diffusion region for reading out charge and further comprising circuitry peripheral to the array, the peripheral circuitry being at a surface of the substrate wherein the substrate is silicon-on-insulator substrate. The modification of Rhodes further teaches the pixel cell further comprises readout circuitry (36, 38) connected to a floating diffusion region (30) for reading out charge and further comprising circuitry peripheral to the array, the peripheral circuitry being at a surface of

the substrate wherein the substrate is silicon-on-insulator substrate (col 6 lines 46-50). It would have been obvious to one of ordinary skill in the art at the time the invention was made to modify Chu to include the readout circuitry and have a silicon-on-insulator substrate like Rhodes to provide a fully operational low cost device and to improve device isolation between devices on the substrate.

Re Claim 32: Chu discloses a pixel cell for an image sensor, the pixel cell comprising:

a photodiode (Fig 4A, area corresponding to electrodes 11) formed below an upper surface of a substrate (1),

the photodiode comprising at least two layers of Si (35, $Si_{1-x}Ge_x$) alternating with at least two layers of $Si_{1-x}Ge_x$ (36, $Si_{1-z}Ge_z$),

wherein the Si layers are not in direct contact with one another and the $Si_{1-x}Ge_x$ layers are not in direct contact with one another, and

wherein the layers are configured to promote ionization by a first carrier type and suppress ionization by a second carrier type in the presence of an electric field (band gap energies are shown in Fig 4B and would create ionization and suppression of carriers) and wherein the first layers are alternated with the second layers;

a gate (12) of a transistor (15) adjacent to the photodiode, the transistor for transferring the amplified charge from the photodiode; and

a graded buffer layer (2) beneath a bottom layer of the photodiode.

Chu fails to disclose an array of pixel cells wherein at least one of the pixel cells comprises the photodiode. Rhodes teaches an array of pixel cells at a surface of a

substrate, wherein at least one of the pixel cells comprises the photodiode. It would have been obvious to one of ordinary skill in the art at the time the invention was made to modify Chu to include the features of Rhodes to provide a fully operational low cost device.

Re Claim 35: Chu discloses a pixel cell for an image sensor, the pixel cell comprising:

a photodiode (Fig 4A, area corresponding to electrodes 11) formed below an upper surface of a substrate (1),

the photodiode comprising at least two layers of Si (35, $Si_{1-x}Ge_x$) alternating with at least two layers of $Si_{1-x}Ge_x$ (36, $Si_{1-z}Ge_z$),

wherein the Si layers are not in direct contact with one another and the $Si_{1-x}Ge_x$ layers are not in direct contact with one another, and

wherein the layers are configured to promote ionization by a first carrier type and suppress ionization by a second carrier type in the presence of an electric field (band gap energies are shown in Fig 4B and would create ionization and suppression of carriers) and wherein the first layers are alternated with the second layers;

a gate (12) of a transistor (15) adjacent to the photodiode, the transistor for transferring the amplified charge from the photodiode; and

a graded buffer layer (2) beneath a bottom layer of the photodiode.

Chu fails to disclose a processor, an image sensor coupled to the processor, the image sensor comprising an array of pixel cells wherein at least one of the pixel cells comprises the photodiode and a floating diffusion region electrically connected to the

transistor and readout circuitry electrically connected to the floating diffusion region. Rhodes teaches a processor (see Fig 14), an image sensor coupled to the processor, the image sensor (See Fig 14) comprising an array of pixel cells (see Fig 2) wherein at least one of the pixel cells comprises the photodiode (See Fig 5, 24) and a floating diffusion region (see Fig 5, 30) electrically connected to the transistor (28) and readout circuitry (36, 38) electrically connected to the floating diffusion region. It would have been obvious to one of ordinary skill in the art at the time the invention was made to modify Chu to include the features of Rhodes to provide a fully operational low cost device.

Re claim 36-37: Chu as modified discloses the pixel cell as above. Chu further discloses wherein a difference between the conduction band energies of the first and at least second layer is greater than a difference between the valence band energies of the first and at least second layer and such that a difference between the valence band energies of the first and at least second layer is greater than a difference between the conduction band energies of the first and at least second layer (see Fig 4B).

Re Claim 55: Chu discloses a pixel cell for an image sensor, the pixel cell comprising:

a photodiode (Fig 4A, area corresponding to electrodes 11) for generating charge in response to light and for amplifying the generated charge, the photodiode being formed within a substrate (1) and below an upper surface thereof and comprising at least two of a first layer (35) having a first band gap (band gap corresponding to

material of $Si_{1-x}Ge_x$) and at least two of a second layer (36) having a second band gap (band gap corresponding to material of $Si_{1-z}Ge_z$),

wherein the first layers are alternated with the second layers, wherein the first layers are not in direct contact with one another and the second layers are not in direct contact with one another, and

wherein the at least two first layers and the at least two second layers are configured to promote ionization by a first carrier type and suppress ionization by a second carrier type in the presence of an electric field (band gap energies are shown in Fig 4B and would create ionization and suppression of carriers)

a gate (12) of a transistor (15) adjacent to the photodiode, the transistor for transferring the amplified charge from the photodiode.

Chu fails to disclose the photodiode being formed within a trench in the substrate. Rhodes teaches a photodiode (Fig 5, 24) in a trench within a substrate. It would have been obvious to one of ordinary skill in the art at the time the invention was made to modify Chu to include the trench as taught by Rhodes in order to improve efficiency of the photodiode (see Rhodes col 10 lines 12-30).

Claims 23-24, 26 and 33-34 are rejected under 35 U.S.C. 103(a) as being unpatentable over U.S. Pub. No. 2002/0171077 to Chu et al. (Chu) in view of U.S. Pat. No. 6,232,626 to Rhodes and U.S. Pat. No. 5,818,322 to Tasumi.

Regarding claims 23-24, Chu as modified discloses the pixel cell as above including wherein the photodiode comprises at least four layers of Si and at least four

layers of SiGe (shown in Fig 4A). Chu as modified fails to disclose wherein the layers of Si are doped to a first conductivity type and wherein the layers of SiGe are doped to a second conductivity type.

Tasumi discloses where the layers of Si are doped to a first conductivity type and the layers of SiGe as taught by Tasumi are doped to a second conductivity type (col 5 lines 66-67 and col 6 lines 1-32). It would have been obvious to one of ordinary skill in the art at the time the invention was made to have the layers of Si are doped to a first conductivity type and the layers of SiGe as taught by Tasumi in order to improve device characteristics, such as enhancing absorption and speed of the image sensor and reducing dark current.

Regarding claims 26, Chu as modified discloses the pixel cell as above. Chu fails to disclose where the first layer is $Si_xGe_{1-x}C_y$ and the second layer is $Si_xGe_yC_z$. Tasumi discloses the pixel cell where the first layer is $Si_xGe_{1-x}C_y$ and the second layer is $Si_xGe_yC_z$ (col 3 line 63). It would have been obvious to one of ordinary skill in the art at the time the invention was made to have the first layer as $Si_xGe_{1-x}C_y$ and the second layer as $Si_xGe_yC_z$ as in Tasumi in order to improve device characteristics, such as enhancing absorption and speed of the image sensor and reducing dark current.

Re Claims 33-34: Chu fails to disclose where x is approximately 0.5 and wherein the layers of Si are doped to a first conductivity type and wherein the layers of Si_xGe_{1-x}, are doped to a second conductivity type. Tasumi teaches a photodiode structure (Figures 1A-1C element 2) with alternating layers of Si and Si_xGe_{1-x}, (col 3 line 63) where x is 0.6 (col 1 line 32) which is approximately 0.5 formed in the groove (4) of the

photodiode. Tasumi also teaches the layers of Si are doped to a first conductivity type and the layers of SiGe as taught by Tasumi are doped to a second conductivity type (col 5 lines 66-67 and col 6 lines 1-32). It would have been obvious to one of ordinary skill in the art at the time the invention was made to include the doping as in Tasumi in order to improve device characteristics, such as enhancing absorption and speed of the image sensor and reducing dark current.

Response to Arguments

Applicant's arguments with respect to claims 1-3, 5-13, 15-27 and 55 have been considered but are moot in view of the new ground(s) of rejection.

The Examiner notes regarding the claim recitation in Claim 7 of "wherein the layers of Si are doped to a first conductivity type and wherein the layers of SiGe are doped to a second conductivity type" does not necessitate the doping of the second conductivity type to be of opposite that of the first conductivity type. Claims 8, 23 and 24 and 33-34 have similar recitations. The applied prior art of Tasumi teaches boron as the dopant for the first conductivity type (interpreted as p-type) and the second conductivity type (interpreted as p-type), which reads on the claimed limitation of a "first conductivity type" and a "second conductivity type" because the claim language does not necessitate the conductivity types being differ. The prior art of Tasumi would not satisfy claim language specifying the layers including dopant of opposite conductivity as disclosed in the Specification paragraph [0049].

Conclusion

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Colleen A. Matthews whose telephone number is (571)272-1667. The examiner can normally be reached on Monday - Friday 8AM-4:30PM.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Lynne Gurley can be reached on 571-272-1670. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/Colleen A Matthews/
Examiner, Art Unit 2811